ELECTRICAL

Installation Calculations

Master :
:
:
Project :
:
:
Location :
:
Date :
Designer :
:
Remarks :

1. INTRODUCTION

This Case Study is based upon the HD384 European Standards and Regulations. In particular, HD384 concern the respective Harmonization Documents (HD) of the IEC 60364 Standards, as they have been harmonized by the European comitee CENELEC.

2. ASSUMPTIONS & RULES OF CALCULATION

(a) Basic Relations:

$U = I \times R$ (Ohm law)

$W = I \times R \times t$ (current heat)

$$R = \frac{2\,l}{K \times A}$$ (circuit resistance)

$P = U \times I$ (power in direct current)

$P = U \times I \times \cos\varphi$ (power of alternating current)

$P = 1.73 \times U \times I \times \cos\varphi$ (power of 3-phase curent)

(b) voltage drop and wire cross-section

(b1) voltage drop u (V)

- single-phase

$$u = 2 \times \left(\frac{\cos\varphi}{K \times A} + \omega \times L \times \sin\varphi \right) \times I \times l$$

- three-phase

$$u = 1.73 \times \left(\frac{\cos\varphi}{K \times A} + \omega \times L \times \sin\varphi \right) \times I \times l$$

where:

- U: mains voltage in V in a 2 wire system between the wires, in a direct current system of 3 wires between the 2 main wires, In a three-phase system between the live wires.
- u: mains voltage drop in V from the start to the end of the circuit
- I: current intensity in A
- R: resistance in Ohm
- W: Energy in W x s
- P: Power in W
- K: conductivity
- cosφ: power coefficient

- A: wire cross-section in mm^2
- l: line length in m
- t: time duration in s
- L: inductive wire resistance in H/m ($\omega=2\pi f$, f=50 Hz)

(b2) cross-section A (mm^2)

A wire is selected so that the flowing current that passes through is less than the maximum permitted (due to its cross-section), and also the voltage drop is less than the desired one (it is calculated using the formulas in paragraph β1).

For the calculation of the allowed current the following parameters are taken under consideration: the wire type, the passage type, the surrounding temperature, the maximum permitted wire temperature, the layout and the function.

(b3) Protection instrumentation

The calculation is done in every line using two different methods:

- The instrument is selected so that the allowed current is greater that the current of the line
- The instrument is selected so that the allowed current is greater that the current of the line, and is one size lesser than the wire's maximum allowed intensity.

(b4) short-circuit current

the allowed short-circuit current is calculated using the following formula:

$$I = \frac{0.115\ A}{\sqrt{t}}$$

where I in kA, A is the wire cross section and t the short-circuit duration

The panel short-circuit current is calculated using the following formula:

$$I = \frac{V}{z}$$

where z the total resistance through the whole length of the wire.

The above formula covers also the three-phase short-circuit situation where the relationship $I = (\sqrt{3}\ V)/2z$ should be applied.

3. PRESENTATION OF RESULTS

The computed results are presented in a table form as follows:

- Line segment
- Line Lenght (m)
- Load (kw)
- Load type

- Cosφ
- Phase
- Voltage Drop (V)
- Wire cross-section (mm^2)
- Fuse (A)

Also, for each panel an analytical calculation takes place, giving results that appear as pointed below::

In the upper part a small table appears with the following columns:

- Load type
- Actual Power (kw)
- Cosφ (KVxA)
- Apparent Power (KVxA)
- Hetero-timing
- Maximum possible demand

These data are given per load type (overall). The value of maximum possible load demand is also given in the lowest section of the table. According to the above data the following values also appear:

- Phase Distribution R S T
- Maximum appearing Intensity (A)
- Overall load demand coefficient
- Intensity for a balanced phase distribution (A)
- Maximum possible appearing intensity (A)
- INCREMENTS
- Reserve (%)
- Motor (A)
- Bulb ignition (A)
- FINAL CURRENT (A)
- Wire type
- Allowed wire current in K.Σ. (A)
- Coefficient of correction
- Allowed wire current (A)
- General Switch (A)
- Fuse or autom. switch (A)
- Supply wire (mm2)
- Degree of panel protection

Network Options	
Phasic Circuit Voltage (V)	230
Cable Type	Copper
Thermal Conductivity (S m/mm2)	56

Electrical Installation Circuit

Net. Sec.	Line Lenght (m)	Load of the Line (KW)	Load Type	Cos phi	Phase	Voltage Drop V	Line Type	Des. Cr.Sect. (mm2)	Cr.Sect. Calc. (mm2)	Max Fuse (A)
A.P		58.20	Panel	0.842	123		3	120	120	160
A.B	17.7	11.20	Panel	1.000	1	1.924	1	16	16	50
A.1	22.8	1.2	Sockets	1	2	1.699	1	2.5	2.5	16
A.2	28.0	0.8	Lighting	1	3	1.391	1	2.5	1.5	10
A.C	12.6	45.00	Panel	0.800	123	0.451	3	70	70	100
B.P		11.20	Panel	1.000	1		1	16	16	50
B.1	3.9	4	Heater	1	1	0.606	1	4	4	20
B.2	16.0	4	One-Phase Cuisine	1	1	1.656	1	6	6	25
B.3	19.7	1	Lighting	1	1	2.039	1	1.5	1.5	10
B.4	14.9	1.5	Sockets	1	1	1.388	1	2.5	2.5	16
B.5	16.9	0.7	Lighting	1	1	1.225	1	1.5	1.5	10
C.P		45.00	Panel	0.800	123		3	70	70	100
C.1	10.2	45	Motor	0.8	123	0.365	3	70	70	100

Electrical Installation Calculations

Net. Sec.	Line Lenght (m)	Load of the Line (KW)	Load Type	Cos phi	Cable Type	No of Paralle Cables	Cr.Sect. Calc. (mm2)	Des. Cr.Sect. (mm2)	Permis. Current No.Cond.	Corr. Factor	Permis. Current (A)	Max Fuse (A)	Line Current\
A.P		58.20	Panel	0.842	J1VV-R		120	120	172.0	0.964	165.8	160	130.2
A.B	17.7	11.20	Panel	1.000	J1VV-R		16	16	56.00	0.964	53.98	50	48.70
A.1	22.8	1.2	Sockets	1	H07V-U		2.5	2.5	19.50	0.964	18.80	16	5.217
A.2	28.0	0.8	Lighting	1	H07V-U		1.5	2.5	19.50	0.964	18.80	10	3.478
A.C	12.6	45.00	Panel	0.800	J1VV-R		70	70	125.0	0.964	120.5	100	81.52
B.P		11.20	Panel	1.000	J1VV-R		16	16	56.00	0.964	53.98	50	48.70
B.1	3.9	4	Heater	1	H07V-U		4	4	26.00	0.964	25.06	20	17.39
B.2	16.0	4	One-Phase Cuisine	1	H07V-U		6	6	34.00	0.964	32.78	25	17.39
B.3	19.7	1	Lighting	1	H07V-U		1.5	1.5	14.50	0.964	13.98	10	4.348
B.4	14.9	1.5	Sockets	1	H07V-U		2.5	2.5	19.50	0.964	18.80	16	6.522
B.5	16.9	0.7	Lighting	1	H07V-U		1.5	1.5	14.50	0.964	13.98	10	3.043
C.P		45.00	Panel	0.800	J1VV-R		70	70	125.0	0.964	120.5	100	81.52
C.1	10.2	45	Motor	0.8	J1VV-R		70	70	125.0	0.964	120.5	100	81.52

Panel Loads Analysis : A.P
Panel Name : MAIN PANEL

Load Type	Installed Power (kW)	Cos phi	Apparent Power (kVA)	Coinc idence	Max Demand (kVA)
Panel	56.20	0.83	67.45	1	67.45
Sockets	1.20	1.00	1.20	1	1.20
Lighting	0.80	1.00	0.80	1	0.80
TOTAL	58.20	0.84	69.13		69.13

Phases Allocation
- L1 (KVA) : 29.95
- L2 (KVA) : 19.95
- L3 (KVA) : 19.55

Max Appeared Intensity of Current (A) : 130.22
Total Demand Factor : 1.00
Intensity for Equal Phases (A) : 100.18
Possible Max Appeared Intensity of Current (A) : 130.22

Increments
- Due to Reserve (%) :
- Due to Motors (A) :
- Due to Lamp Starting (A) :

Total Current (A) : 130.22
Cable Type : J1VV-R
Permitable Cable Current in Norm.Cond. (A) : 172.00
- Installation method : In a pipe, inside the wall
- Environment temperature : 33
- Temperature correction factor : 0.964
- Transit : On the surface of an element, on the wall or inside the wall (naked or in a pipe)
- Number of circuits - multicore cables : 1
- Grouping coefficient : 1.000

Correction Factor : 0.964
Permitable Cable Current (A) : 165.81

Selected
- Main Switch (A) :
- Fuse or Circuit Breaker (A) (A) : 160
- Supply Cable (mm²) : 120
- Deegre of Protection of Panel : IP
- Embedded to another Panel : No

Panel Loads Analysis : B.P
Panel Name : FLOOR PANEL

Load Type	Installed Power (kW)	Cos phi	Apparent Power (kVA)	Coinc idence	Max Demand (kVA)
Heater	4.00	1.00	4.00	1	4.00
One-Phase Cuisine	4.00	1.00	4.00	1	4.00
Lighting	1.70	1.00	1.70	1	1.70
Sockets	1.50	1.00	1.50	1	1.50
TOTAL	11.20	1.00	11.20		11.20

Phases Allocation		
L1 (KVA)	:	11.20
L2 (KVA)	:	
L3 (KVA)	:	
Max Appeared Intensity of Current (A)	:	48.70
Total Demand Factor	:	1.00
Intensity for Equal Phases (A)	:	16.23
Possible Max Appeared Intensity of Current (A)	:	48.70
Increments		
Due to Reserve (%)	:	
Due to Motors (A)	:	
Due to Lamp Starting (A)	:	
Total Current (A)	:	48.70
Cable Type	:	J1VV-R
Permitable Cable Current in Norm.Cond. (A)	:	56.00
Installation method : In a pipe, inside the wall		
Environment temperature	:	33
Temperature correction factor	:	0.964
Transit : On the surface of an element, on the wall or inside the wall (naked or in a pipe)		
Number of circuits - multicore cables	:	1
Grouping coefficient	:	1.000
Correction Factor	:	0.964
Permitable Cable Current (A)	:	53.98
Selected		
Main Switch (A)	:	63
Fuse or Circuit Breaker (A) (A)	:	50
Supply Cable (mm²)	:	16
Deegre of Protection of Panel	:	IP
Embedded to another Panel	:	No

Panel Loads Analysis : C.P
Panel Name : SUBPANEL

Load Type	Installed Power (kW)	Cos phi	Apparent Power (kVA)	Coinc idence	Max Demand (kVA)
Motor	45.00	0.80	56.25	1	56.25
TOTAL	45.00	0.80	56.25		56.25

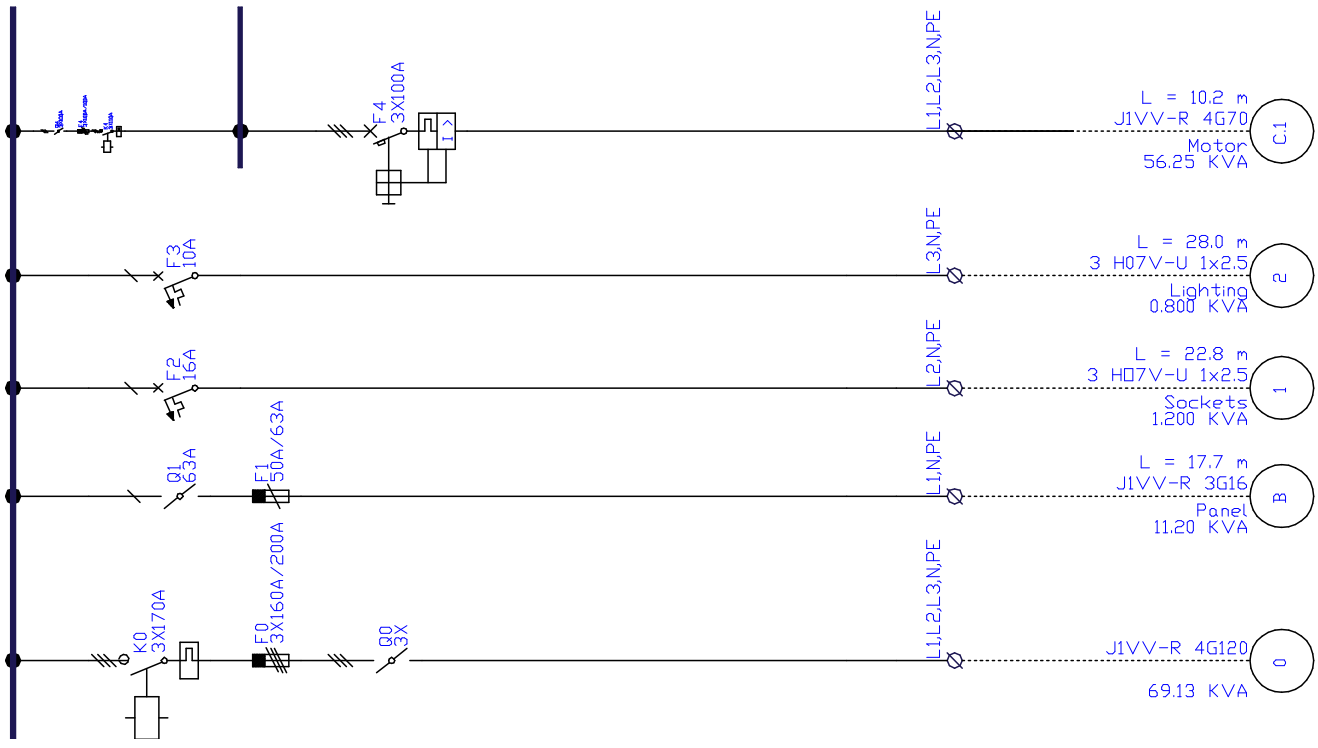
Phases Allocation		
L1 (KVA)	:	18.75
L2 (KVA)	:	18.75
L3 (KVA)	:	18.75
Max Appeared Intensity of Current (A)	:	81.52
Total Demand Factor	:	1.00
Intensity for Equal Phases (A)	:	81.52
Possible Max Appeared Intensity of Current (A)	:	81.52
Increments		
Due to Reserve (%)	:	
Due to Motors (A)	:	
Due to Lamp Starting (A)	:	
Total Current (A)	:	81.52
Cable Type	:	J1VV-R
Permitable Cable Current in Norm.Cond. (A)	:	125.00
Installation method : In a pipe, inside the wall		
Environment temperature	:	33
Temperature correction factor	:	0.964
Transit : On the surface of an element, on the wall or inside the wall (naked or in a pipe)		
Number of circuits - multicore cables	:	1
Grouping coefficient	:	1.000
Correction Factor	:	0.964
Permitable Cable Current (A)	:	120.50
Selected		
Main Switch (A)	:	100
Fuse or Circuit Breaker (A) (A)	:	100
Supply Cable (mm²)	:	70
Deegre of Protection of Panel	:	IP
Embedded to another Panel	:	YES

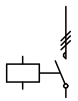
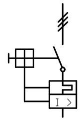
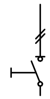
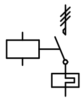
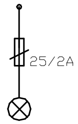
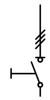
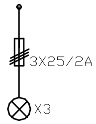
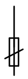
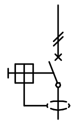
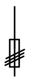
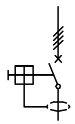
Cables Checking

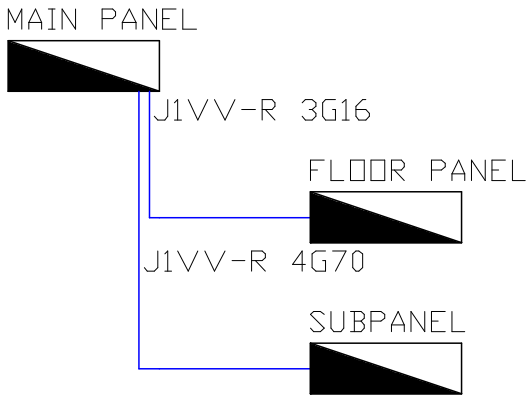
There are not any Lines that cannot Calculate Cables

Protection Devices Checking

There are not any Lines that cannot Calculate Protection Devices



ELECTRIC SYMBOLS LABEL					
	3-POLE REMOTE CONTROL SWITCH		3-POLE MOTOR SWITCH		2-POLE ISOLATING CIRCUIT BREAKER
	3-POLE REMOTE CONTROL SWITCH WITH THERMALS		INDICATOR LIGHT		3-POLE ISOLATING CIRCUIT BREAKER
	3-POLE FUSE DISCONNECTOR CYL.FUSE		3 INDICATOR LIGHTS		1-POLE MINIATURE CIRCUIT BREAKER
	1-POLE SCREWING FUSE		2-POLE RELAY		3-POLE MINIATURE CIRCUIT BREAKER
	3-POLE SCREWING FUSE		4-POLE RELAY		3-POLE ISOLATING CIRCUIT BREAKER PACCO



Voltage Drop at Lines of Circuit

Voltage Drop at Line	A-->B.1	:	2.530	V	(1.100%)
Voltage Drop at Line	A-->B.2	:	3.580	V	(1.557%)
Voltage Drop at Line	A-->B.3	:	3.963	V	(1.723%)
Voltage Drop at Line	A-->B.4	:	3.312	V	(1.440%)
Voltage Drop at Line	A-->B.5	:	3.149	V	(1.369%)
Voltage Drop at Line	A-->A.1	:	1.699	V	(0.739%)
Voltage Drop at Line	A-->A.2	:	1.391	V	(0.605%)
Voltage Drop at Line	A-->C.1	:	0.816	V	(0.205%)

Most Malign Linwe	A-->B.3	:	3.963	V	(1.723%)

Bill of Materials - Costing

No	Description	Un.Pr.	Quant.	Disc. %	VAT %	T.Price
	CABLES					
	H07V-U 1x1.5	1.00	221.40		19.0	263.47
	H07V-U 1x2.5	1.50	84.00		19.0	149.94
	H07V-U 1x4	1.80	11.70		19.0	25.06
	J1VV-R 3G16	2.00	17.70		19.0	42.13
	J1VV-R 4G70	2.20	22.80		19.0	59.69
	HO7V-U 1x2.5	1.50	144.60		19.0	258.11
	HO7V-U 1x6.0	1.70	48.00		1.00	82.42
					9.00	
	ELECTRICAL OUTLETS					
	PROTECTION DEVICES					
	ONE PHASEMiniature Circuit Bre	10.00	3.00		19.0	35.70
	ONE PHASEMiniature Circuit Bre	12.00	2.00		19.0	28.56
	ONE PHASEMiniature Circuit Bre	13.00	1.00		19.0	15.47
	ONE PHASEMiniature Circuit Bre	15.00	1.00		19.0	17.85
	ONE PHASEScrewing Fuses	12.00	1.00		19.0	14.28
	ONE PHASEScrewing Fuses	13.00	3.00		19.0	46.41
	ONE PHASEScrewing Fuses	15.00	3.00		19.0	53.55
	3-PCircuit Breakers 100A	18.00	1.00		19.0	21.42
	ONE PHASEPACCO Switches	22.00	1.00		19.0	26.18
	3-PPACCO Switches 100A	30.00	1.00		19.0	35.70
	ONE PHASETumpler Switches	25.00	2.00		19.0	59.50
	ONE PHASEBases of Screwing Fus	28.00	1.00		19.0	33.32
	3-PBases of Screwing Fuse100A	31.00	1.00		19.0	36.89
	3-PBases of Screwing Fuse200A	35.00	1.00		19.0	41.65
	OTHER EQUIPMENT					
						1347.30

TECHNICAL REPORT OF ELECTRICAL INSTALLATION

Master :
:
:
Project :
:
:
Location :
:
Date :
Designer :
:
:
:
Remarks :
:

0. GENERAL

This Case Study is based upon the HD384 European Standards and Regulations, which comes from the harmonization of the IEC 60364 Standards by the European comitee CENELEC.

1. Main Supply – Counters

The supply comes from the Public network 220/380 V-50Hz. The area where the bar cabinets and the counters are to be mounted is shown in the drawing plans. One counter per property and an extra counter for the communal spaces are anticipated.

Near the counters a direct ground will be constructed and connected by a ground wireway made of steel-tube or galvanised iron to the ground-bar of the bar cabinets.
Both the entries of the supply cable and its mechanical protection will be indicated by the public company of electricity.

2. Cabling - Conduit.

i. The panels connecting wiring will be of the NYY or NYM type and in the case where the installation is embodied to the walls steel pipes will be used.

ii. Wherever the installation is embodied and is not necessary to be of the sealed type the wiring will be of the NYA type passing through plastic pipes. In the case of a sealed installation (visible or embedded) the NYM type or the NYA type shall be used. In the case of the NYA type steel pipes will be used with internal insulation. As sealed type rooms we consider among other the bathrooms, boiler-room, etc.

iii. Especially, when the installation is embodied in the concrete, plastic pipes of the HELIFLEX type will be used.

iv. The pipe sizes, depended upon the cross-sectional area of the cables, are given below:

Cables	Pipes
3x1.5 mm	Φ 13.5mm

3x2.5 mm, 5x1.5 mm	Φ 16 mm
3x4 mm, 5x2.5 mm	Φ 21 or Φ 23mm
3x6 mm, 5x4 mm	Φ 21 or Φ 23mm
3x10 mm, 5x6 mm	Φ 29mm
3x16 mm, 5x10 mm	Φ 36mm

For larger cross-sectional wire sizes galvanised iron pipes will be used or plastic pipes for ground passages.

v. All lines shall include a ground wire.

vi. The horizontal wiring will be installed in a height greater than 2.5 m.

vii. Lighting lines will consist of wires of 1.5 mm cross-section diameter, whereas power lines will consist of wires of 2.5 mm cross-section diameter.

3. Distribution Panels

The distribution panels will be made of metal, having a protection grade of IP54 or alternately single or three phased standardised panels of thermoplastic material. Each panel will consist of separate phase, neutral and ground bars. Furthermore it will also consist of:

- Main fuses (of the melting type).
- Main switch.
- Escape relay of 30mA.
- Wiring according to the panel plan.

4. Temporary supply

The temporary supply will be done according to regulations by the proprietor and with the responsibility of the managing engineer.

It is anticipated that the temporary supply is located in a sealed metallic box, which is grounded and locked during the non-working hours with the responsibility of the proprietor.

An automatic escape relay must also be installed. Prior the use of the supply, the supervisor engineer must be called for inspection; otherwise he has no liability in case of an accident. All extension cables shall include a grounded wire, regardless of the type of tools they supply. The way that they are unfolded must be such that any damage is excluded and thus accidents are avoided.
(away of personnel passages, vehicles, machines etc.)

5. Notes

i. The wall plugs (outlets) will be grounded and installed in a height of 50 cm from the floor.
ii. All switches will be installed in a height of 80 cm from the floor.
iii. The position of the lights is shown in the drawing plans. Their types are also shown in the plans.
iv. In case of a sealed installation, all outlets, switches and lights will be of the sealed type.

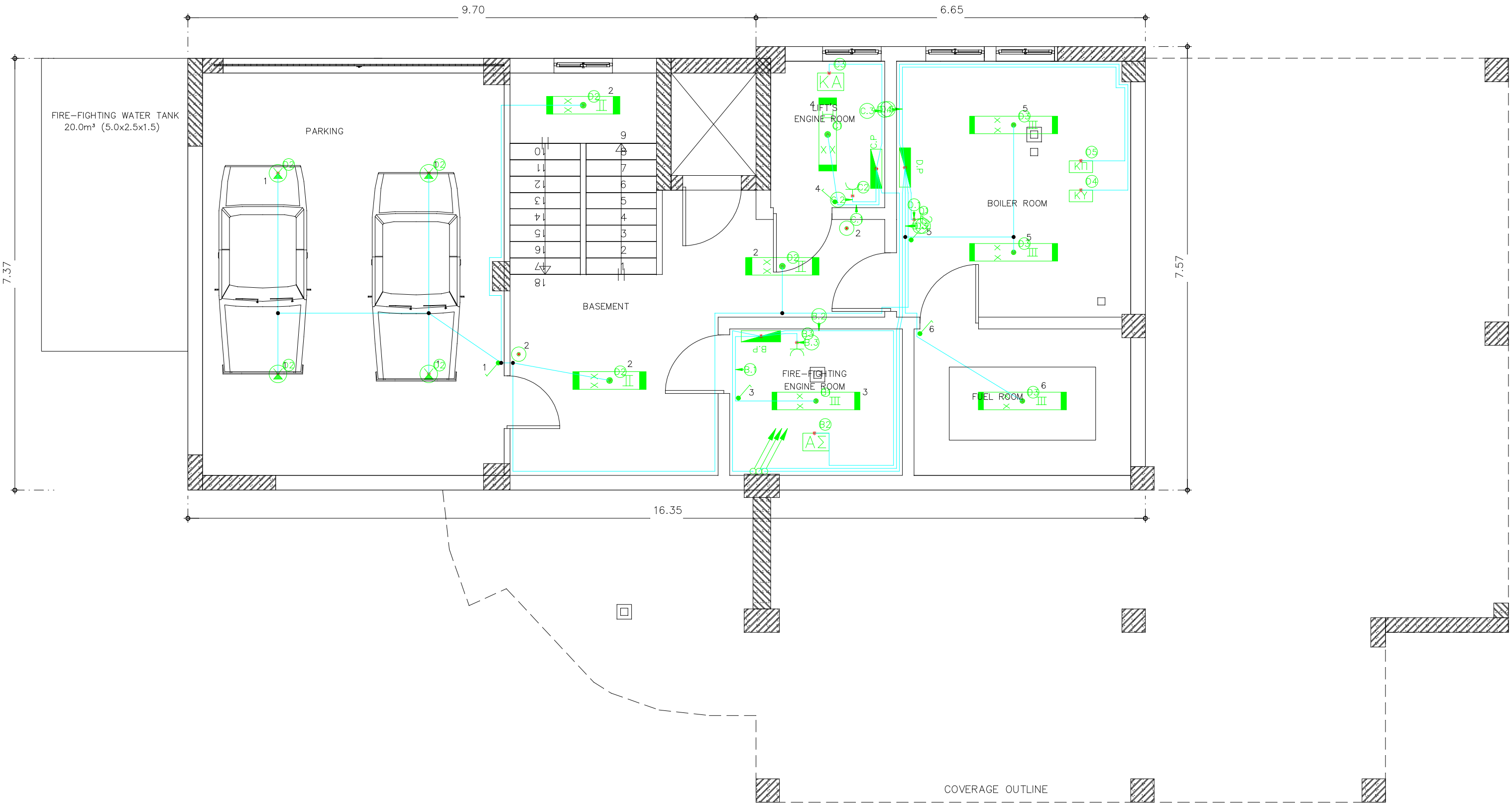
6. Additional protection notes

A bridging of the sanitary ware should be made as well as a connection of the metallic water supplies to the grounded bars.

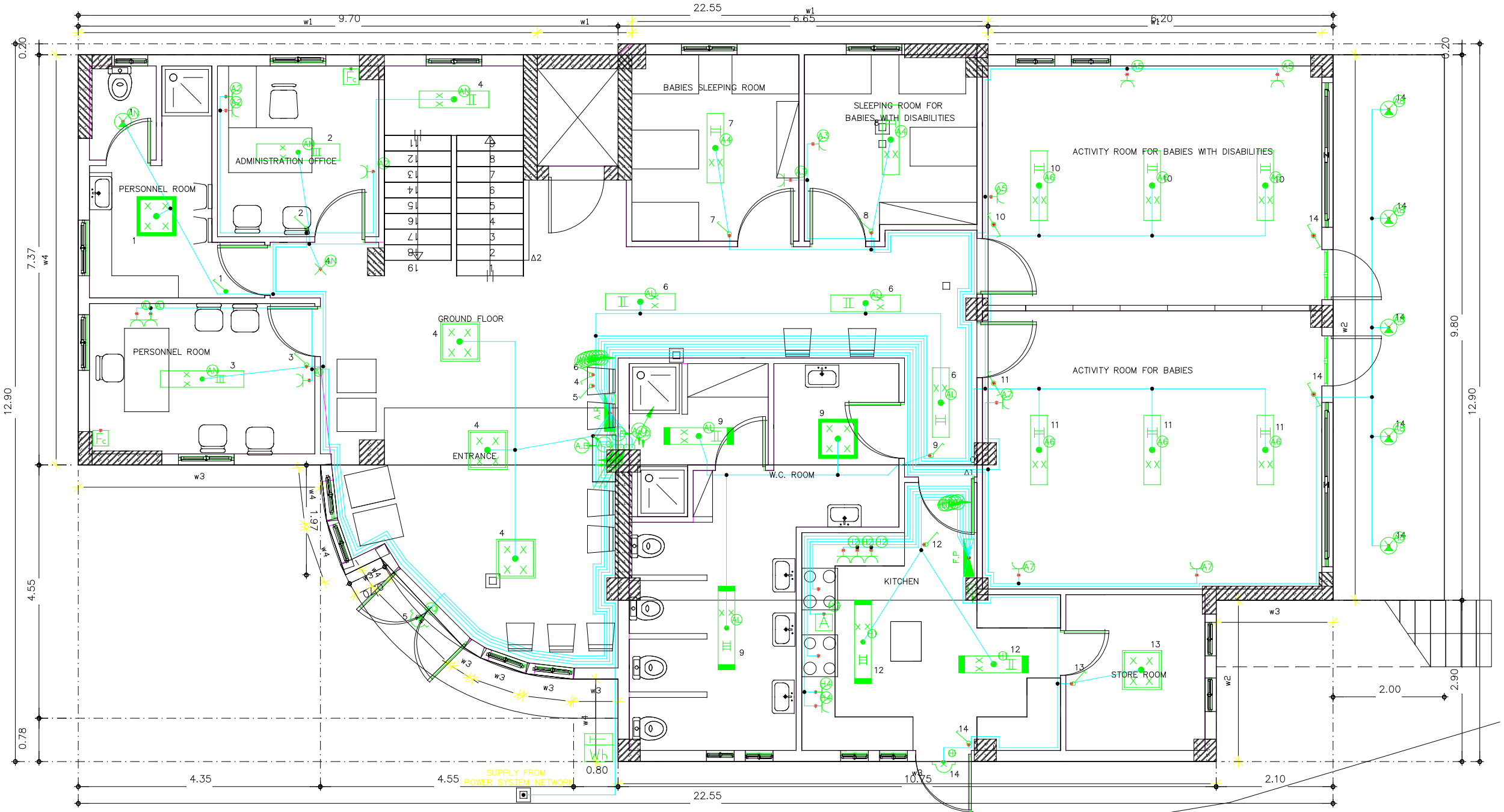
7. Trials

The insulation resistance must be measured. Its value must exceed 250 MOhms.

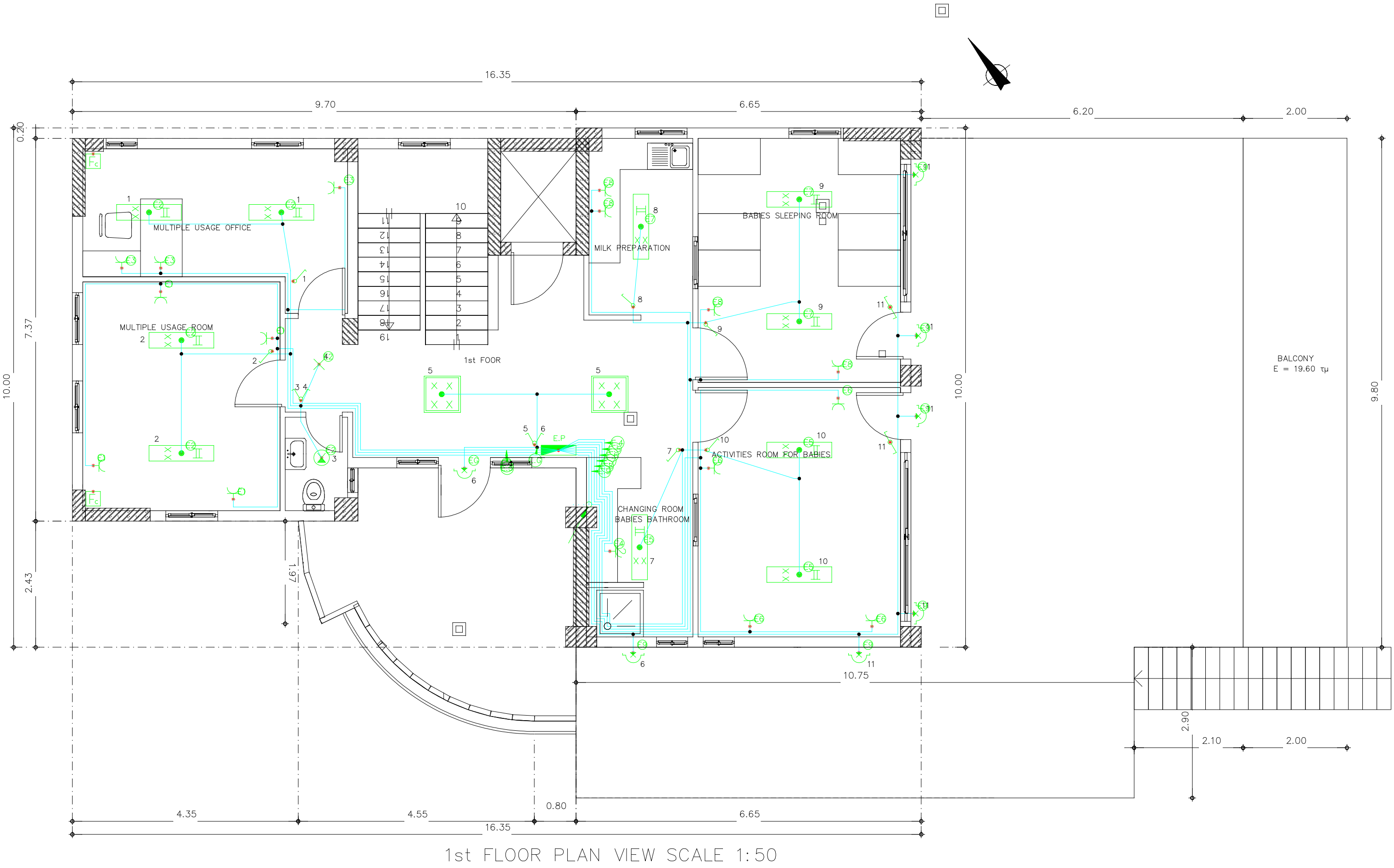
The Author



BASEMENT PLAN VIEW SCALE 1:50



GROUND FLOOR PLAN SCALE 1:50



1st FLOOR PLAN VIEW SCALE 1:50